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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Fiber Composite

(72) Dittmar, Harri - Germany (Federal Republic of) ;
Wahl, Ludwig - Germany (Federal Republic of) ;
Greening, Giorgio - Germany (Federal Republic of) ;
Heym, Manfred - Germany (Federal Republic of) ;

(73) Same as inventor

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Fiber composite

The present invention relates to a process for producing fiber composites from a thermoplastics matrix and unidirectional, parallel reinforcing fibers.

5 Fiber composites based on thermoplastics are increasingly used in automotive construction. It has therefore been necessary to develop cost-effective, high-throughput processes for producing such composites.

10 DE-C-2,948,235 describes a process for producing a glass fiber reinforced sheet of thermoplastic. In this process, fiber mats needled in a double belt press and a molten thermoplastic are pressed and consolidated together under a pressure of from 0.1 to 20 bar to form a fiber reinforced sheet. The comparatively low pressure is
15 sufficient to impregnate the loose glass mats all over without leaving air bubbles. Since the fibers in the glass mats are non-oriented, the resulting composites have the same, albeit comparatively low, strength and stiffness properties in all directions of the plane of
20 the sheet.

Composites formed from thermoplastics and unidirectional reinforcing fibers are described in
25 GB-A-1,485,586. They are produced by the batchwise pressing of layers of thermoplastics films and layers of parallel fiber bundles at above the softening temperature of the thermoplastic under pressures of about 70 bar. It is found that pressing times of an hour or longer are required to bring about complete impregnation of the fiber layers, ie. wetting of the individual filaments
30 making up the fiber bundles.

EP-C-56,703 describes a continuous process for producing a composite material from a thermoplastics polymer and parallelized reinforcing fibers in the form of rovings.

35 These rovings are pulled through the molten thermoplastics polymer by the pultrusion technique. To then complete the impregnation and wetting of the

individual filaments, the rovings must be mechanically opened out by pulling them under tension over spreader surfaces and forcing the molten thermoplastic between the individual filaments by fulling. This has the consequence
5 that only comparatively small throughputs are obtainable and that broken ends occur. In addition, air bubbles remain in the product. If the viscosity of the thermoplastic is reduced by the addition of a solvent or plasticizer, then the product contains residues of these
10 additives.

It is an object of the present invention to develop a continuous process for producing fiber composites whereby parallel, mechanically unconnected fiber bundles can be quickly and completely impregnated with a
15 melt of a thermoplastic. The fiber composites produced by the process shall be free of air bubbles and shall be very strong and stiff in the direction of alignment of the reinforcing fibers and be very tough.

We have found that this object is achieved according to the present invention by continuously
20 introducing parallel, mechanically unconnected fiber bundles and a thermoplastic into a double belt press, pressing under a specific pressure of not less than 10 bar at more than 10°C above the melting point of the
25 thermoplastic for a period of from 20 seconds to 20 minutes, and cooling under pressure.

In a preferred embodiment, a double belt press is used sealed off on all sides. Such apparatus is described in EP-A-212,232. There it is used for producing thermoplastics webs with or without reinforcement from woven
30 textile, glass fiber or metal fabrics or from bonded fiber webs. Comparatively low pressures are sufficient to obtain complete impregnation of the fabrics or fiber webs. The publication mentioned does not provide any
35 indication that by employing pressures above 10 bar it is also possible to obtain complete impregnation of parallel fiber bundles. In the woven fabrics used in EP-A-212,232,

the parallel fibers are mechanically interconnected. On using non-interconnected fiber bundles and deploying high pressures it was likely that the fiber bundles would become dislocated, destroying the parallel arrangement and hence reducing the level of mechanical properties.

5 The process according to the present invention makes it possible to obtain complete and uniform impregnation of the fiber bundles; that is, the molten thermoplastic penetrates into the fiber bundles, wetting and
10 enveloping the individual filaments, even in the case of comparatively thick layers, or tapes, 0.5 mm or more in thickness.

In this way it is possible to obtain high fiber contents of more than 50% by volume, which is otherwise
15 only possible in a continuous method by impregnating with a solution of the thermoplastic. The fiber composite produced according to the present invention preferably has a fiber content of from 30 to 70, in particular from 40 to 65, % by volume.

20 The composite obtained is free of holidays and air bubbles. This makes it possible to mold and press the molding compound without employing the kind of high pressures which would be necessary if air bubbles had to be pressed out.

25 The process according to the present invention is carried out on a double belt press as described for example in EP-A-212,232. It is preferably sealed off on all sides, so that no melt can escape at the side. This can be accomplished by suitable sealing measures.

30 The reinforcing fibers can consist of the customary materials, for example glass, carbon or aromatic polyamides. They are introduced into the double belt press in the form of parallel fiber bundles, either combined into rovings or loosely side by side. They are
35 not mechanically interconnected; that is, they are not in the form of woven or knitted fabric. The basis weight of the fibers is preferably 100-800 g.m⁻², in particular

200-600 g.m⁻². The fiber strands can be from 10 to 150 cm, preferably from 30 to 100 cm, in width. The fiber bundles can be drawn off as rovings from a conventional creel; however, it is advantageously possible to use a warp beam made up directly of filament ends.

The thermoplastic can be introduced into the double belt press in various forms. Preferably, it is introduced as an extruded melt; but it can also be introduced in the form of a film which is then melted in the intake zone of the press. It is even possible to use thermoplastics fibers, in which case they are advantageously premixed with the reinforcing fibers to form a hybrid yarn. It is finally also possible to apply the thermoplastic to the fiber bundle in powder form by sprinkling or from an aqueous dispersion, in which case it is then necessary to evaporate the water before the fiber bundle is introduced into the double belt press.

In the double belt press, the fiber bundles are impregnated with the thermoplastics melt. This is done under a pressure of not less than 10 bar, preferably of from 20 to 100 bar. The temperature should be sufficiently high for the thermoplastic to be present as a melt; that is, the temperature is more than 10°C, preferably more than 20-120°C, above the melting point of the thermoplastic. The residence time on the double belt press is from 20 seconds to 20 minutes, preferably from 40 seconds to 4 minutes. The double belt press has a cooling zone in which the composite is cooled to below the melting point and thereby consolidated.

The composite according to the present invention is suitable for use as a molding compound from which it is possible, by molding and pressing, to produce structural components for use in various sectors, for example automobiles, sports articles, furniture, etc.

EXAMPLE

A glass fiber warp beam having a basis weight of 400 g/m² is arranged on a braked unrolling station

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upstream of a double belt press. Two further braked unrolling stations are creeled with polypropylene films. The films are 60 μ m in thickness and are made of an isotactic polypropylene having a melt flow index of 40.

5 The sheet of fibers drawn off the warp beam is parallelized with the aid of a reed positioned a short distance upstream of the intake point of the double belt press and introduced into the double belt press in a parallel arrangement between the two sheets of thermoplastic. The

10 unidirectional glass fibers are completely impregnated with polypropylene in the heating zone at 50 bar and 240°C and at a speed of 1 m/min and cooled and fixed under pressure in the solidifying matrix in the subsequent cooling zone. The result obtained is a high-

15 quality unidirectional tape having a fiber volume content of 50% and a thickness of about 0.3 mm. For production widths of 1 m this represents a throughput of 32 kg/h, which illustrates the good economics of the production process.

We claim:

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1. A process for producing a fiber composite from a thermoplastics matrix and unidirectional reinforcing fibers by impregnating the fibers with a thermoplastics melt, which comprises continuously introducing parallel, mechanically unconnected fiber bundles and a thermoplastic into a double belt press, pressing under a specific pressure of not less than 10 bar at more than 10°C above the melting point of the thermoplastic for a period of from 20 seconds to 20 minutes, and cooling under pressure.
2. A process as claimed in claim 1, wherein the thermoplastic is introduced into the double belt press as a melt.
3. A process as claimed in claim 1, wherein the thermoplastic is introduced into the double belt press as a film.
4. A process as claimed in claim 1, wherein the thermoplastic is introduced into the double belt press in fiber form, preferably in the form of a hybrid yarn with the reinforcing fibers.
5. A process as claimed in claim 1, wherein the thermoplastic is introduced into the double belt press as a powder applied to the reinforcing fibers by sprinkling or from an aqueous dispersion.
6. A process as claimed in claim 1, which is carried out on a double belt press sealed off on all sides.

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Abstract of the Disclosure: Fiber composites which are suitable for molding, for example into auto parts, are produced in a continuous process by briefly pressing fiber bundles and molten thermoplastics in a double belt press under a pressure of not less than 10 bar to impregnate the fiber bundles to such an extent that the individual filaments are completely wetted.